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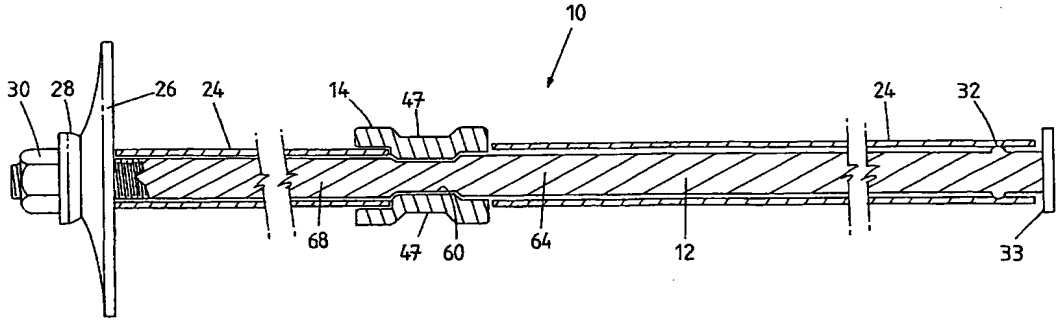
(54) Title: A YIELDING ROCK BOLT



(57) Abstract: A yielding rock bolt (10) having a solid metal shaft (12) with a relatively wide portion (64) and a relative narrow portion (60) and an anchor member (14) mounted about the shaft (12). The anchor member (14) has longitudinal bore (40) which is of lesser dimension than the relatively wide portion (64). The anchor member (14) is mounted about the relatively narrow portion (60) adjacent the wide portion (64). In use the shaft (12) is extruded through the anchor member (14) to cause the rock (10) to yield as a rock face moves.

WO 2004/055327 A1

TITLE

"A YIELDING ROCK BOLT"

FIELD OF THE INVENTION

The present invention relates to a yielding rock bolt.

SUMMARY OF THE INVENTION

In accordance with one aspect of the present invention there is provided a yielding rock bolt arranged to be inserted into a hole in a rock surface, characterised by comprising a shaft formed of a solid metal bar, the shaft having a first end and a second end, the shaft having a relatively wide portion adjacent the first end thereof and a relatively narrow portion adjacent the wide portion, an anchor member having a longitudinal bore mounted about the shaft at the relatively narrow portion and adjacent the wide portion, the longitudinal bore having at least a portion of lesser dimension than the relatively wide portion

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described, by way of example, with reference to the accompanying drawings, in which :

Figure 1 is a perspective view of a yielding rock bolt in accordance with an embodiment of the present invention;

Figure 2 is a longitudinal cross-sectional view of the rock bolt of Figure 1;

Figure 3 is a longitudinal cross-sectional view of a shaft having an anchor member mounted thereabout;

Figure 4 is a view similar to Figure 3 showing the anchor member and the shaft being formed into a particular profile by swage press members;

Figure 5 is a view similar to Figure 3 showing the shaft and the anchor member after being formed by the swage press members shown in Figure 4; and

Figure 6 is a longitudinal cross-sectional view of a rock bolt in accordance with a second embodiment of the present invention formed by the steps illustrated in Figures 3 to 5.

DETAILED DESCRIPTION OF THE DRAWINGS

In the drawings, there is shown a yielding rock bolt 10 comprising a shaft 12 and an anchor member 14 mounted about the shaft 12 . The shaft 12 is in the form of a solid metal bar. The anchor member 14 has a longitudinal bore 15 as can be seen in Figure 2, which receives the shaft 12. The shaft 12 has a first end 16 and a second end 18. Further, the shaft 12 has a relatively wide portion 20 adjacent the first end 16 and a relatively narrow portion 22 adjacent the wide portion 20 and extending to the second end 18. The anchor member 14 is located adjacent the wide portion 20 at the narrow portion 22.

Preferably, the longitudinal bore 15 of the anchor member 14 is dimensioned so that the anchor member 14 can fit over the narrow portion 22 snugly and engage with an inner end of the wide portion 20 as shown in Figure 2. However, a portion of the longitudinal bore 15 is of lesser dimension than the wide portion 20.

Further, the shaft 12 is provided with a debonding sheath 24 formed of a suitable material such as plastics material extending along and about the full length of the shaft 12 apart from the region at which the anchor member 14 is disposed.

The rock bolt 10 is also provided with a rock-face engaging plate 26 adjacent the second end 18 of the shaft 12. The shaft 12 is formed at the second end 18 with a screw threaded portion.

The plate 26 is fitted over the screw threaded portion of the shaft 12. Then a washer 28 is placed over the second end 18 and a threaded nut 30 is then threadedly engaged with the end 18 to retain the plate 26 and the washer 28 in place.

Further, it is envisaged that the shaft 12 will be provided with a widened stop portion of increased dimension adjacent the first end 16 such as a welded circle 32 formed of relatively hard material inside the sheath 24.

Still further, it is envisaged that a resin mixing paddle 33 may be tack welded to the end 16 of the shaft 12.

Also, the anchor member 14 has a portion 34 which is relatively wide adjacent the wide portion 20 of the shaft 12. Extending towards the second end 18 the anchor member 14 has a portion 36 which tapers inwardly towards the second end 18 of the shaft 12 as can best be seen in Figure 2.

The anchor member 14 may be manufactured from heat treated steel such as 41/40 steel heat treated to harden it. Further, the bore 15 of the anchor member 14 is nitrided to prevent molecular welding between the anchor member 14 and the shaft 12. Thus, it is particularly important that the anchor member 14 be treated in the longitudinal bore 15 to prevent welding between the anchor member 14 and the shaft 12.

In use, a hole is drilled into a wall of a rock face and the first end 16 of the rock bolt 10 is inserted into the hole until the plate member 26 engages with the rock face around the hole. The anchor member 14 is disposed about the shaft 12 adjacent an inner end of the wide portion 20 remote from the first end 16 of the shaft 12 (as can best be seen in Figure 2).

The drilled hole around the rock bolt 10 is then filled with a bonding material such as resin, grout or expansion shells in known manner. The anchor member 14 is secured in place by bonding with the bonding material whilst the shaft 12 is capable of sliding longitudinally within the hole relative to the anchor member 14 because of the debonding sheath 24.

If movement of rock causes a portion of the rock face to begin to break away, this portion of the rock face is held in place by the rock bolt 10 being secured at the anchor member 14. However, this movement will cause the wide portion 20 of the shaft 12 to be pulled through the anchor member 14. The rock bolt 10 therefore yields as the rock face moves preventing the possibility of sudden failure of the rock face. In this movement the wide portion 20 of the shaft 12 being of larger dimension than a portion of the longitudinal bore 15 of the anchor member 14 is extruded through the anchor member 14. This provides a predictable and substantially constant force on the anchor member 14.

This force continues until the stop 32 engages with the anchor member 14 at which point the force applied to the anchor member 14 is increased considerably because the stop portion 32 will not extrude through the anchor member 14. At this stage the shaft 12 is subjected to maximum load which is the ultimate tensile strength of the shaft 12.

It is envisaged that the yielding rock bolt 10 of the present invention could be manufactured by a number of techniques. In the embodiment of the present invention illustrated in Figures 1 and 2 it is envisaged that the narrow portion 22 could be formed by taking a solid bar of uniform dimension throughout and then extruding a portion of the bar to form the narrow portion 22 extending to the second end 18. In this case, the narrow portion 22 would be relatively long as shown in the accompanying drawings.

In a preferred embodiment of the present invention an anchor member 14 having a relatively wide bore of substantially uniform dimension is disposed about a shaft 12 of substantially uniform dimension throughout its length. The anchor member 14 is then swaged onto the shaft 12 in known manner so as to reduce the dimension of the longitudinal bore and to reduce correspondingly the dimension of the shaft 12 with which the anchor member 14 is engaged. In this embodiment the shaft 12 would only have a narrow portion 22 adjacent the anchor member 14, which narrow portion 22, is a relatively short section of the shaft 12 adjacent the wide portion.

The preferred embodiment of the present invention is illustrated in Figures 3 to 6 of the accompanying drawings.

In Figure 3 there is shown in a shaft 12 which is of substantially uniform thickness. Mounted about the shaft 12 is an anchor member 14. In this embodiment, the anchor member 14 is a generally cylindrical member with a longitudinal bore 40. The bore 40 is preferably, as shown, of substantially uniform cross section throughout its length.

The shaft 12 and the anchor member 14 of Figure 3 are placed in a swage press which includes a pair of swage press members 41 as seen in Figure 4. The swage press members 41 are profiled so as to have a relatively deep mid-portion 42. A right hand end portion 43 as seen in Figure 4 is of less depth. The portions 42 and 43 are interconnected adjacent the shaft 12 by a sloped portion 44.

At the left hand end of the swage press members 41 as seen in Figure 4, there is a portion 49 connected to the deep mid-portion 42 by a right angle portion 45.

In operation, the swage press members 41are pressed together in known manner so as to apply deforming force to the anchor member 14 on the shaft 12 as shown in Figure 4. This causes the anchor member 14 to deform inwardly in a mid-portion 47 thereof in a shape complementary to the swage press members 41.

The deformation of the anchor member 14 causes a complementary deformation of the shaft 12 to occur. As can be seen in Figure 5, the bore 40 of the anchor member 14 has an inwardly deformed mid section 47 connected to a non-deformed right hand section 48 by a sloped portion 50. Further, the anchor member has a left hand portion 52 which is non-deformed and is connected to the mid-section 47 by a right angle portion 54.

Further, the shaft 12 has an inwardly deformed portion 60 corresponding in shape to the deformed portion 47 of the anchor member 14. Further, the shaft 12 has a sloped portion 62 connecting the deformed portion 60 to a non-deformed right hand portion 64.

Further, the shaft 12 has a right angle portion 66 connecting the deformed portion 60 to a non-deformed left hand portion 68.

As shown in Figure 6, the yielding rock bolt 10 produced as described above in relation to Figures 3 to 5, is fitted up in similar manner to the yielding rock bolt of Figures 1 and 2. The rock bolt of Figure 6 is mounted in a hole in a rock face as described above for Figures 1 and 2. Once again, the rock bolt of Figure 6 holds the rock face in place if a portion of the rock face begins to break away. The movement of the rock face causes the wide portion 64 of the shaft 12 to be pulled through the anchor member 14 with the sloped portion 62 leading.

The anchor member 14 causes deformation of the non-deformed portion 64 of the shaft 12. Thus, the shaft 12 is extruded through the anchor member 14. This produces a predictable and substantially constant force on the anchor member 14.

Modifications and variations as would be apparent to a skilled addressee are deemed to be within the scope of the present invention

CLAIMS:

1. A yielding rock bolt arranged to be inserted into a hole in a rock surface, characterised by comprising a shaft formed of a solid metal bar, the shaft having a first end and a second end, the shaft having a relatively wide portion adjacent the first end thereof and a relatively narrow portion adjacent the wide portion, an anchor member having a longitudinal bore mounted about the shaft at the relatively narrow portion and adjacent the wide portion, the longitudinal bore having at least a portion of lesser dimension than the relatively wide portion.

2. A yielding rock bolt according to claim 1, characterised in that the narrow portion of the shaft is a relatively short section of the shaft adjacent the wide portion.

3. A yielding rock bolt according to claim 1, characterised in that the narrow portion of the shaft extends from the wide portion to the second end of the shaft.

4. A yielding rock bolt according to any one of the preceding claims, characterised in that a debonding sheath is mounted about the shaft in regions thereof apart from the anchor member.

5. A yielding rock bolt according to claim 4, characterised in that the debonding sheath extends along the full length of the shaft apart from the region at which the anchor member is disposed.

6. A yielding rock bolt according to any one of the preceding claims, characterised in that the anchor member is formed of heat treated steel.

7. A yielding rock bolt according to claim 6, characterised in that the anchor member has a relatively wide portion adjacent the wide portion of the shaft and a portion tapering inwardly towards the second end of the shaft.

8. A yielding rock bolt according to claim 6 or 7, characterised in that the longitudinal bore of the anchor member is treated to prevent sticking between the anchor member and the shaft.

9. A yielding rock bolt according to claim 8, characterised in that the anchor member is nitrided in the longitudinal bore to prevent sticking between the anchor member and the shaft

10. A yielding rock bolt according to any one of the preceding claims, characterised in that a rock engaging plate is mounted about the shaft adjacent the second end thereof.

11. A yielding rock bolt according to any one of the preceding claims, characterised in that a stop portion is mounted about the shaft adjacent the second end thereof.

12. A yielding rock bolt according to claim 11, characterised in that the stop portion is a welding ring of relatively hard material.

13. A yielding rock bolt according to any one of the preceding claims, characterised in that a mixing paddle is attached to the first end of the shaft.

14. A yielding rock bolt according to claim 2, characterised in that the anchor member initially has a substantially uniform longitudinal bore of sufficient dimension to fit over the shaft, and the relatively narrow portion of the shaft is formed by placing the anchor member in a swage press so as to deform the anchor member to form at least a portion of the longitudinal bore of reduced dimension and a corresponding portion of the shaft of similarly reduced dimension.

15. A method of securing a rock face characterised by drilling a hole therein, inserting a yielding rock bolt according to any one of the preceding claims into the hole with the first end foremost, filling the hole with bonding material such that if an adjacent portion of the rock face begins to breakaway the wide

portion of the shaft is extruded through the anchor member so that the rock bolt yields as the rock face moves.

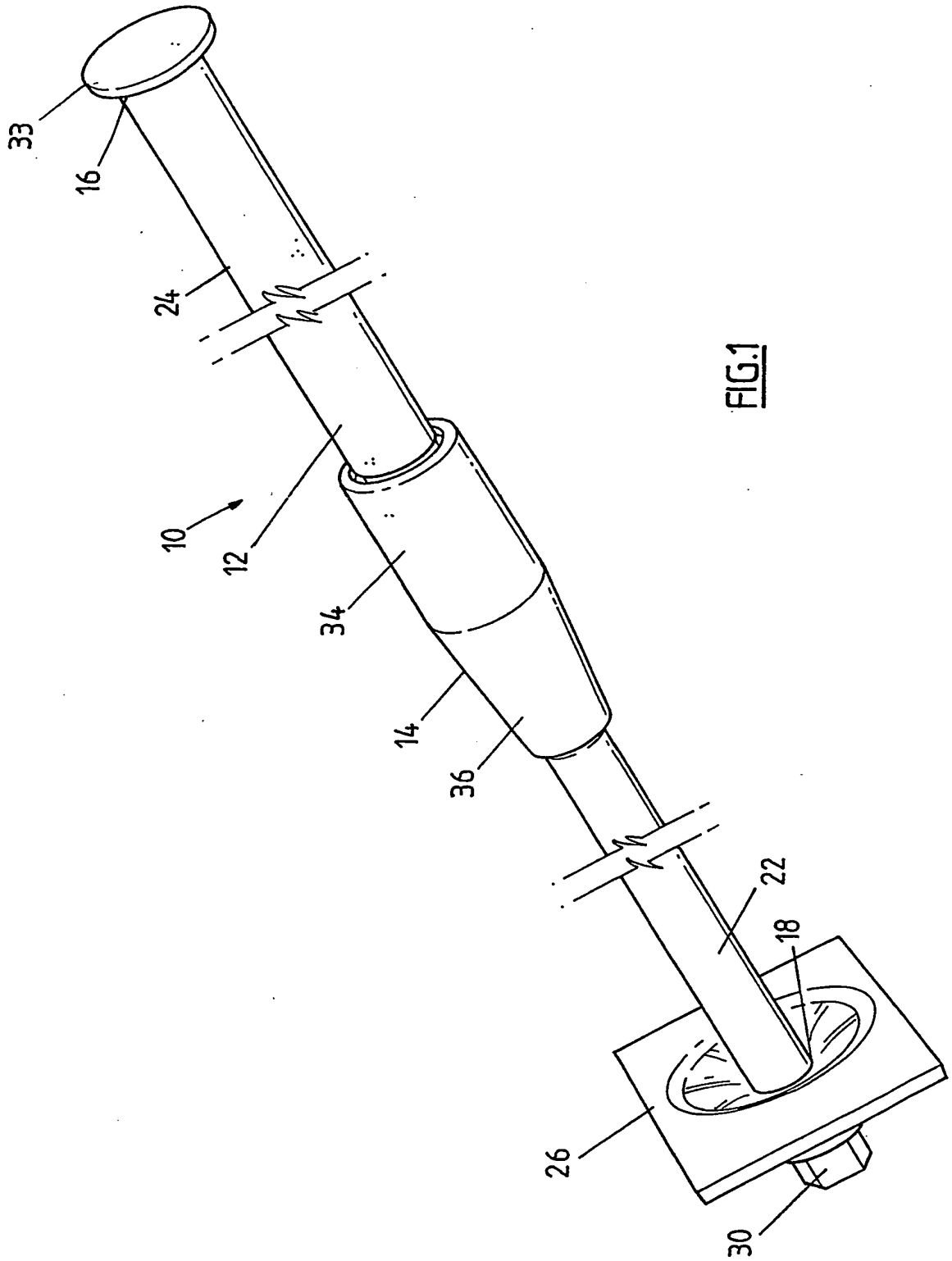


FIG.1

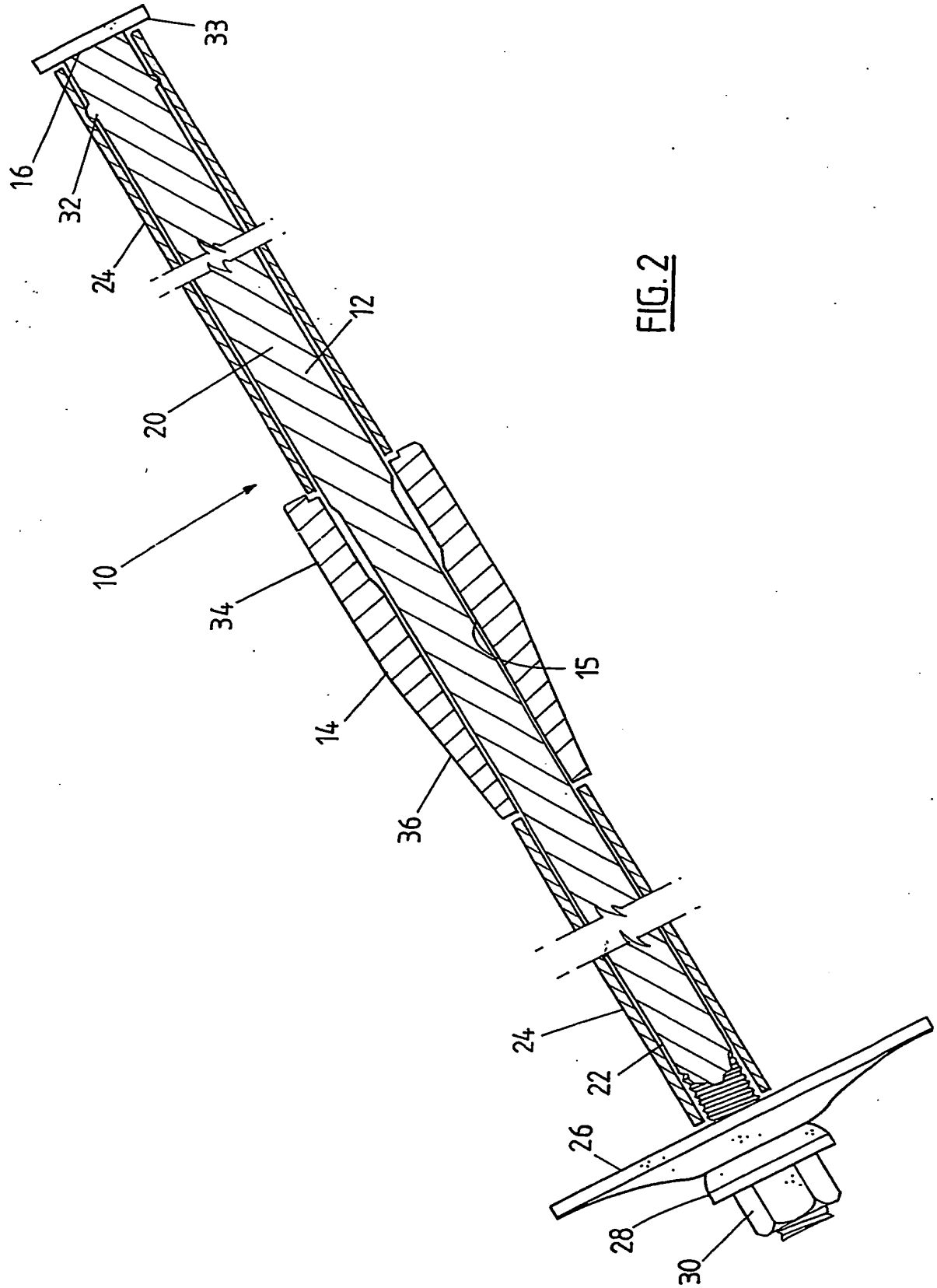


FIG.2

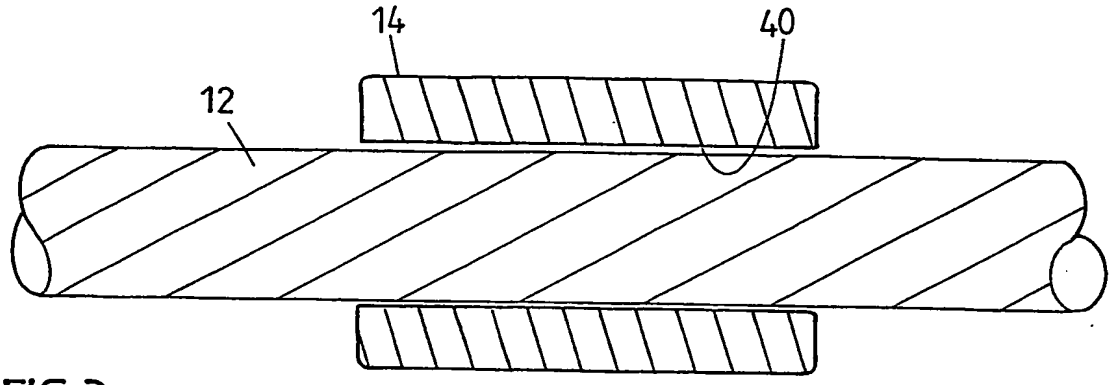


FIG.3

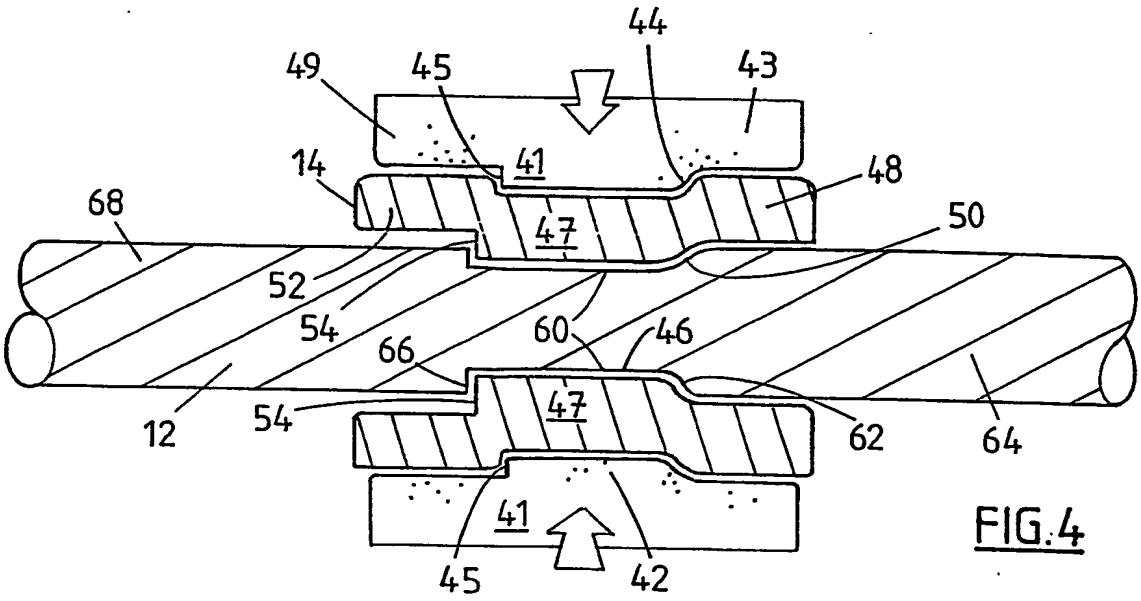


FIG.4

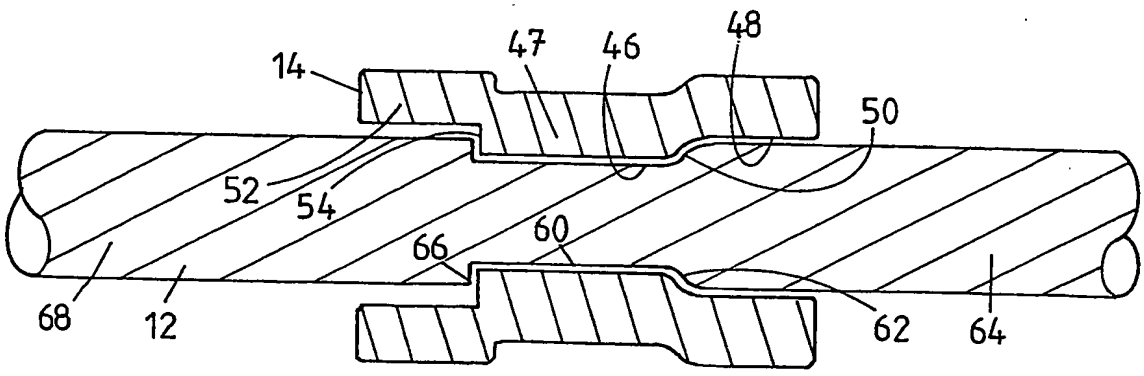


FIG.5

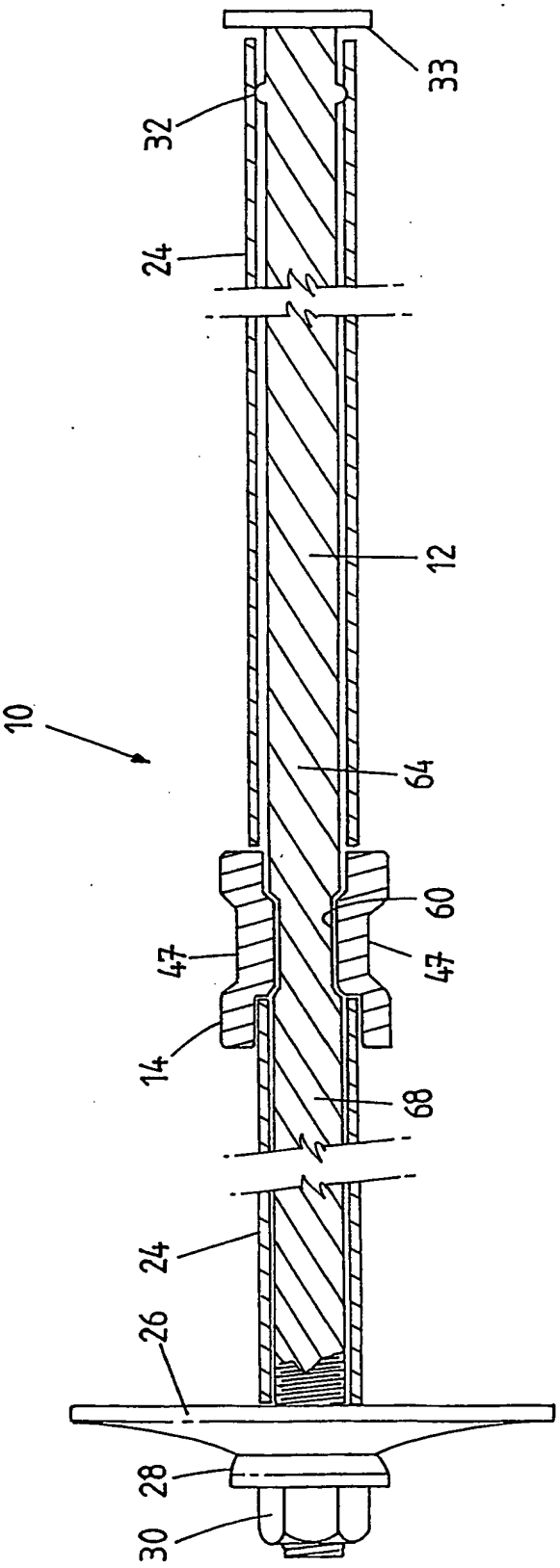


FIG.6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2003/001667

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: E21D 21/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPAT: 1.(yield+ or deform+ or extrud+ or swage+) and (collar+ or sleev+ or sheath+ or cylind+ or annul+)
2.(narrow+ or small+ lesser or reduced)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2141804 A (THYSSEN INDUSTRIES AG) 3 January 1985 See whole document	1
A	US 4440526 (KOPPERS et al.) 3 April 1984 See whole document	1

☐ Further documents are listed in the continuation of Box C ☒ See patent family annex

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 January 2004	16 JAN 2004
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer **BARRY STEPHENS** Telephone No : (02) 6283 2106

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU2003/001667

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member					
GB	2141804	BE	899784	DE	3320460	FR	2547351
US	4440526	AU	77864/81	CA	1172477	DE	3047709
		ES	8302848	FR	2496752	ZA	8106373
		ZW	23681				

END OF ANNEX